SOFT COMPUTING APPROACH TO DESIGN A DECISION SUPPORT SYSTEM FOR SOLID WASTE MANAGEMENT

SYNOPSIS

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ABSTRACT

Solid waste is a natural outcome of daily activities of human, which can never stop, and gets increasing as there is growth in population and living standards of human. Due to lack in management and improper disposal of solid waste urban cities are facing various problems like diseases transmission, fire hazards, odor nuisance, atmospheric and water pollution, aesthetic nuisance and economic loses. The only solution is Solid Waste Management and selection of suitable site for solid waste disposal. If this is not done at right time then everybody has to pay a lot in future. Management of solid waste is become a very big and sensitive problem in front of many municipalities, corporation and urban city in the world. Geographic Information system helps us to view, understand, question, interpret and visualize huge spatial and non spatial data in many ways that reveals relationships, patterns and trends in the form of maps, reports and charts. This study is identifying most suitable dumping sites for study area. While selecting suitable dumping site which will be environmentally safe and acceptable to people, we can take advantage of soft computing methods such as MCDA, AHP, Clustering approach, Fuzzy classification, decision tree along with Geographical Information System (GIS) to provide an opportunity to integrate field parameters and other relevant associated features of the study area.

KEYWORDS: Solid waste, MCDA, AHP, Clustering, Fuzzy classification, Decision tree, Geo-referencing, Geospatial Analysis, Geographic Information system, Dumping site, solid waste.

1. INTRODUCTION

Today every municipalities, corporation and urban city in the world is facing very big and sensitive problem of managing solid waste. Solid waste is a natural outcome of daily activities of human, which can never be stop, and gets increasing as there is growth in population and living standards of human[1]. Due to lack in management and improper disposal of solid waste many urban cities are facing various problems like diseases transmission, fire hazards, odor nuisance, atmospheric and water pollution, aesthetic nuisance and economic loses. So waste disposing is an important part of waste management system. Disposal of waste is to be done in such a manner which will avoid the environmental pollution and sustainable to environment and society. Generally in urban cities solid waste management comes under the Municipality.

We found that most of the municipalities of urban cities dump their solid waste at a dumping ground. Maximum time there is no treatment facility on solid waste, and the waste collected from the city is merely dumped at such site. Such sites should be in use since long period and may need to be assessed for its capacity to handle more dumping, as well as to access its suitability for installing treatment and disposal method. Urban cities with a growing population generate tons of municipal solid waste daily that comprises of wastes from households, markets, commercial area, Industrial area, public and private Institutions, common places, road sweeping and drain cleaning [1].

If we take a sight at various urban cities in the world about solid waste generation and its management the below tabled information is found.

Sr. No.	City	Country	Population	Kilograms per capita		Kilograms per household		Type of management
				Year	Day	Year	Day	
1	Adelaide	Australia	1,089,728	490	1.3	1176	3.2	Landfill Site
2	Bamako	Mali	1,809,106	256	0.7	1712	4.7	Dumping Site
3	Belo	Horizonte, Brazil	2,452,617	529	1.4	1639	4.5	No legal Site
4	Bangalore	India	7,800,000	269	0.7	942	2.6	Disposal site
5	Canete	Peru	48,892	246	0.7	1083	3	Dumping Site
6	Curepipe	Republic of Mauritius	83,750	284	0.8	1135	3.1	Landfill Site
7	Delhi	India	13,850,507	184	0.5	938	2.6	Disposal site
8	Dhaka	Bangladesh	7,000,000	167	0.5	761	2.1	Disposal site
9	Ghorahi	Nepal	59,156	167	0.5	805	2.2	Landfill Site
10	Kunming	China	3,500,000	286	0.8	903	2.5	Landfill Site
11	Lusaka	Zambia	1,500,000	201	0.6	1107	3	Dumping in open space
12	Managua	Nicaragua	1,002,882	420	1.1	2182	6	Disposal site
13	Moshi	Tanzania	183,520	338	0.9	1386	3.8	Dumping Site
14	Nairobi	Kenya	4,000,000	219	0.6	1314	3.6	Recycling, Dumping Site
15	Quezon	City, Philippines	2,861,091	257	0.7	1286	3.5	Dumping Site
16	Rotterdam	Netherlands	582,949	528	1.4	1030	2.8	Landfill Site
17	San	Francisco, USA	835,364	609	1.7	1400	3.8	Landfill Site
18	Sousse	Tunisia	173,047	394	1.1	1586	4.3	Dumping, Landfill Sites
19	Tompkins	County, USA	101,136	577	1.6	1340	3.7	Landfill Site
20	Varna	Bulgaria	313,983	435	1.2	1131	3.1	Disposal site

From the observation of above data it is clear that most of the urban cities use dumping sites for dumping the municipal solid waste, some uses Landfill sites and some uses disposal sites. But it is clear that all municipalities requires suitable and echo friendly, sustainable site for dumping, land filling or disposal site or sites for management of municipal solid waste. [2] The anagement of solid waste involves the processes such as [1]

1. Generation of solid waste
2. Reduction by sorting of waste
3. Reuse of reusable waste
4. Recycling of waste
5. Handling
6. Collection
7. Transfer
8. Transport
9. Transformation
10. Disposal

To implement the advanced techniques for all above processes and disposal, MSW management must pay big amount. To develop buildings, operating sanitary landfills and incineration plants, huge investments must be needed, as well as to incur substantial operation and maintenance it again demands costs. Also it becoming highly difficult to find suitable sites for waste treatment facilities due to the thinking's of the Not In My Backyard attitude amongst societies. Urban city's solid waste generation will be double every 10 years if solid waste generation is increased between 3 to 5 per cent for a year and the population of city is also going on increasing due to migration from rural to urban area. [3]

To compromise with all above problems, most of the municipality adopts to use dumping site for solid waste which is the best alternative for waste management with lowest price.

The study made against solid waste management of municipally throughout the world is not so different, at global level most of the urban cities facing similar problems regarding continuously generation of solid waste. The rate of generation of solid waste is directly propositional to the growth of population and living standard. Generation of solid waste can be decreased but cannot be stop. Continuously increase in solid waste is becomes a very challenging problem for most of the urban cities and it must be solved seriously as it is related to the health of urban cities and problematic to the environment and will be cause to unbalance the environment.

The decision makers of the municipality have to select the suitable dumping site by considering number of available criteria and its proximity to the dumping site, total available land, its cost, its soil type. The selected solid waste dumping site must be sustainable to society

as well as environment and it will not create serious problems related to human health. While deciding sustainable solid waste dumping site decision makers have to access and evaluate huge amount of spatial and non spatial data of that region. It is not so easy to access and evaluate the huge amount of data manually. The process of deciding solid waste dumping site is becomes so complex and time consuming due to requirement of evaluation of huge data. Suitable solid waste site must have environmental safety criteria and attributes that will enable there is no unacceptable risk to people or environment. Criteria for site selection include natural physical characteristics as well as socioeconomic, ecological and land-use factors. Multi-criteria analysis is to be done for solid waste disposal site selection.

Now days with advanced technology it is possible to solve very complex and critical problems of accessing huge amount of data. Combination of GIS and decision making method Multi Criterion Decision Analysis (MCDA) is helping the decision makers. To make more advancement and more accurate decision making for solid waste dumping site, the advantage of parallel combination of Geographical Information System (GIS) and soft computing tools such as Fuzzy classification, clustering approach, and decision tree can be applied to the complex and huge data to provide an opportunity to integrate field parameters with population and other relevant data can be applied.

To set the model for identification of solid waste dumping site the data of Nanded City (Nanded Waghala Municipal Corporation Nanded) is to be treated as sample data throughout the research work.

3. LITERATURE REVIEWS

In [4] Authors has present a method based on Geographical Information Systems (GIS) modeling to identify a set of criteria which needs to be considered for the proposed MSW landfill site in the city. During study total 11 input map layers including topography, settlements, roads, slope, geology, land use, floodplains, aquifers and surface water are evaluated and prepared to be used in the analysis in GIS environment. Thematic maps of the selected criteria were developed within the paradigm of standard GIS software. All the data layers are derived and prepared from the related maps by scanning, geo-referencing, geo-rectifying and digitizing the relevant information. The information compiled from literature about the safe distances to a landfill site is used to determine the buffer zones for each layer. After creating the classes for each layer by using buffer zones, each layer is converted into individual raster maps. After the preparation of all input data layers the method AHP is selected among the decision rules to analyze the data for landfill site selection by using GIS. Authors have not considered the political, financial or economical constraints during their study.

In [5] GIS integrated standard methodology for selection of site is used. The primary data is collected through field survey in every wards of Nabadwip Municipality with structured questionnaire. Also researcher has conducted face-to-face interview of 20 households at random basis. The secondary data of Industrial waste, hospital waste and other sources of waste are taken from Nabadwip Municipality. Then she has collected maps to get the locations of schools, colleges, commercial houses, water bodies, drainage lines, road networks land use etc from Nabadwip Municipality authority. At the data analysis stage she has done logical as well as systematic scientific investigation. The methodology of this study covers some sequential steps. The three phase GIS spatial decision making capability is used for searching suitable sites. Also a decision support technique known as Multi-criteria Analysis (MCA) is used to take the decision.

In [6]study was devoted to select potential areas for suitable solid waste dumping sites for Bahir Dar Town. While doing study they used primary and secondary data. The primary data were collected from field surveys and observations. The secondary data was acquired from various sources like internet, reports, books, journals, government institutions and other documents. The

main data used for this study were SPOT5 image of the town with spatial resolution of 5 m, master plan of the town and topographical map of the town. They enhanced SPOT5 image by pre-processing operations like radiometric, image restoration and rectification. Then they used spatial multi-criteria analysis technique to identify the most suitable solid waste site. The solid waste disposal site selection mapping was done using multi criteria evaluation and creating layers to yield a single output map. An analytical hierarchy process (AHP) was used to produce weights. Then pair-wise comparison on the basis of criteria of weights is made and its values are put into a matrix having 9 fractions from 1/9 to 1/2 representing importance of one factor against another in the pair. Then every element in the matrix was divided by the sum of the respective column. Finally and average from the elements from each row of the matrix was calculate. The consistency ratio (CR) was calculated in order to ensure that the comparison of criteria made by decision makers was consistent.

In [7] Solid Waste Management for Pimpri-Chinchwad Municipal Corporation was done by using GIS and GPS technology. In this project Geo coding of the all the bins across the city were marked on the GIS mapping database and real time vehicle movement (GPS location of the vehicle on which a GPS device was installed) were monitored against them as per route. Overall city vide75 different routes were identified and geo coded with GIS map. An intelligence algorithm/logic was developed in web based application to flag the bin as “Serve”, when a waste collector vehicle stops near a bin within a specified distance for a sufficient period. Using this data, a web base application was developed to monitor the waste pick performance by PCMC officials and an extended status view was also developed at the PCMC website for citizens to view the status of bin online for their own locality. This project was somewhat heavy budget and just for management of collecting solid waste throughout the city not to allocate the location for solid waste material.

In [8] Md. MujiborRahman and et all main objective is to allocate a suitable site for solid waste disposal for Khulna city of Bangla Desh by using GIS approach. In this study they have done logical as well as systematic and scientific investigation. This study involves a technique in which various stages or steps of collecting data were used. The GIS is used 1. To capture, store and mage spatially referenced data, 2. To perform analysis of spatially referenced input data, 3.

To perform sensitivity and optimization analysis easily, 4.Formaking spatial decision making. A particular set has been chosen for the study area by using Different steps of multi-criteria evaluation. For generating criteria deductive approach is used. For determining the scores of criteria indirect qualitative determination approach is used. A decision making system is designed to select an optimal option among a broad set of alternatives by combining expert system and computer models together. GIS software and expert classification shell has been used to locate suitable sites for solid waste disposal.

In [9] authors has tried to find out the potential waste disposal sites using Remote Sensing and GIS techniques for Karaikudi Muncipality. During the study spatial as well as non spatial data is used. The software like Arc GIS 9.3, version developed by ESRI and ERDAS 9.2 version developed by ERDAS are used. The spatial data like satellite data, toposheets, Administrative boundaries, soil lithounits are rectified to the same coordinate system. Thebase amp layers have been digitized and the digitization errors have been rectified. The attributes has been given and the layers are prepared in to layouts for the description of the study area. The vector layers are prepared for the overlay analysis to find out the appropriate sites for solid waste disposal. They have adopted the method for weighted overlay analysis. The parameters like Land use, Road, Ground water depth, soil, relief, Litho units are considered and weightages are given in accordance to its importance to the favorable sites for disposal. Al the above parameters have been extracted from the toposheets, satellite imageries, and websites. All the parameters have been generated as single layer in vector format. The KaraikudiMuncipality Office has been plotted with reference to the toposheet, Google earth imagery and also field visit experience. The buffer 5 and 4 km distance from Municipality office has been created in Arc GIS Toolbox. The above parameters are extracted with this 5 km buffer in study area. All these vector layers are converted into a Raster format. All the parameters are given different weightages for a total of 100%. Each parameter has different categories and the weightage ranks for the separate category has been allotted base on its influence to the selection of solid waste disposal sites.

In [10] By following some restrictions like street' directions, no U-Turns rules, and facts that the truck should follow true-shape rout. For distance criteria selection results are shown in meters by Network Analyst. He suggests reordering the stop-points in order to find the shortest route. Also

he suggests avoiding traffic congestion. Finally, the closest route for the solid waste collection was produced by pushing the “solve” button of Network Analyst. In this study solid waste route for vehicle in Laxmi Nagar by using Arc map Network Analyst is optimized. With the GIS technique, optimum route was identified which found to be cost effective and less time consuming when compared with the existing run route. The route is to be obtaining by Arc GIS is 5.1 km. and time is 8 Hr. 35 min. The costs for these operations are 965 rupees per day, 28,950 rupees per month 352225 rupees per year. The cost is save up to 14% per month. Th analyses also the good option for these type of study.

In [11] Surendra Kumar has proposed to use Analytical Hierarchy Process (AHP) for selection for primary landfill site. In which weights are assigned to different criteria. The criteria were aggregated and suitability index is generated using weighted linear combination (WLC) technique in GIS environment. The Suitability index (0-10) values are classified into four categories to select the landfill site. To do all above the need of spatial database is fulfilled by collecting data from Local Authority interviews, Waste Local Plans, Planning and Waste Strategy Documents. There is no any kind of compromise with criteria to ensure environmental sustainability and public health protection. Facility attributes, such as addresses, operators, regulatory and planning status, capacities, types of process and wastes processed were compiled and presented on suitable thematic maps. GIS is used for measurements of transport distances and processing locations mapping. Waste Local Plan, planning, policy and strategy documents, topographical, sensitive receptor, transport network and land use data are efficiently collected and quality assured prior to being imported and analyses in waste management GIS database. In his research he had strictly analyzed all the important soil parameters. In his proposed model particularly nine steps are included which can be listed as 1) Conceptualization of the evaluation criteria and the hierarchy of the landfill allocation problem. 2) Creation of the spatial database. 3) Construction of the criteria – layers within the GIS environment. 4) Standardization of the criteria – layers. 5) Estimation of the relative importance for the criteria using AHP. 6) Calculation of the suitability index 7) zoning of the area using suitability index and suggest the most suitable area as a site. 8) Sensitivity analysis and validation of the model 9) Final selection.

In [12]authors with the aim to develop the effective system of municipal solid waste management in Rostov-on-Don there was set a task to develop methodology of geoinformation system(GIS) for efficient management on the basis of monitoring the accumulation, collection, transportation and disposal of MSW on the territory of Rostov-on-Don. The created system implies sequential solution of a number of optimization problems in al stage of waste management to achieve the main goal. The main implementation phases of the multi-level geographic information system GIS areSystem level "MSW Accumulation, The database of the population, The database of small to medium sized enterprises, The database of projects under construction. The database on enterprises in the sector of housing and utilities infrastructure, Database links with the electronic map, binding to an electronic map of the bins, the development of the optimization model of solid waste collection, Development of the software module, Analysis of the existing system, Analysis of existing system for disposal of solid waste, Implementation.

In [13] Ayo Babalola, Ibrahim Basu hasused IKONOS satellite imageries covering the study area as well as toptographic maps were used to extract the following information: Land use like residential areas, settlement, roads, water bodies, groundwater, commercial areas, sensitive areas, recreation, educational institution, agricultural, etc. In the same manner rainfall data, wind direction and speed, and soil are extracted from the topographic maps. By using Arc GIS processing software the geographic data and features required for the preliminary stage are extracted. For selection of site all data was processed by using the Arc GIS software. The initial part bears vector maps, which form the layers of land use, rainfall, soil , slope, aspect, etc. All these layers were then entered into the model builder and thereafter converted to raster format from where buffering of all the constrain mapping were carried out. After this, classification was done and union of all the buffered layers. The layers bear cells and these cells are weighted, all the layers are then overlaid to produce the overall output map. In this study the relative importance weight for each factor was obtained from the use of pair-wise comparison matrix method form a decision making process called Analytical Network Process (ANP) and carried out using the Super decision software. To derive the elevation and the slope maps, point data of longitude, latitude and their elevations were processed in GIS environment to produce contour

maps using the surface analysis module of the Arc GIS software. From the contour maps the digital elevation model (DEAM) was created from which the slope layers were derived.
The methodology employed in this study described the GIS and Multi-criteria techniques for the selection of suitable sites for the disposal of municipal solid wastes in Damaturu town. The study shows the ability of GIS as a veritable tool for decision support. The techniques considered a number of siting criteria ranging from a accessibility, land use, to natural factors which are very important in identifying as wellas in locating sites which poses minimum or no risk to the environment. In the initial analysis which comprises of the use of Analytic Network Process (ANP) to determine the relative weights of factors and multiple criteria suitability in raster GIS, for teen sites were selected as a result of the query for suitability. Finally, seven sites were selected for the management of solid waste in the study area. Researcher has shown that siting criteria can be modified based on local constraints, as such this study considered the available and important criteria.

In [14] Bilgehan Nas and et al says that landfill is a common solution for final disposal of municipal solid waste in Turkey. In the present study they have used a vector-based GIS software ArcGIS9.0and its extensions were used as the GIS tool to perform multi-criteria evaluation analysis. Multiple choices for site problem are devised by using MCA analysis. Available information of study area was digitized on-screen digitizing method is used to digitize the topographic maps Land use and land use capacity classification maps were obtained from Turkish General Directorate of Rural Services (GDRS)For siting methodologies used are based on composite suitability analysis using map overlays and their extension to include statistical analysis. This method is known as index overlay. The index overlay method is used to evaluate each location according to weighted criteria. In this method each factor maps will be assigned ranking, as well as the maps themselves receiving different weights. All scored maps will be assigned to common scale. The weights indicate the relative importance.

In [15] A. Karkazi and et al. had suggested a methodology in which they had utilizes GIS technology to accept input spatial and non spatial data of study area, and to manage and visualization of the geographic data while fuzzy logic is applied for the analysis of the data and to retrieve the final results of selection of site. In this study researchers have to provide a plan for locating a site for

landfill for Egypt government. In their research work it is said that fuzzy approach is most applicable for the applications where decision criteria are not working properly for example where the boundary area between two areas is gradual. Inexact boundaries of area overlap appear to be more the rule than the exception in geographical problems. Using fuzzy logic analysis they had decided the membership function value for each criterion. A output variable is set which is having the values poor suitability and appropriate suitability and using the same process each site is assigned a value between 0 to 100 for suitability subset poor and appropriate. In the same manner they also take the Boolean logic analysis results for site selection and made comparison of both methods, which shows that fuzzy logic analysis is more appropriate rather than Boolean logic analysis for site selection.

[16] is the intellectual study done by Pece V. Gorsevski and et al. This paper represents a technique devised using combination of GIS-based multi-criteria decision analysis to discover the suitability for landfill site for Polog Region, Macedonia. The environmental as well as economic factors were analyzed using multi-criteria decision method and these criteria were updated up to standard enough using fuzzy membership functions. These standardized criteria where mixed together using the integrated techniques analytical hierarchy process and ordered weighted average. Using AHP weights for attributes of different criteria where discovered and using OWA discover possible all ranges of decision options to find out uncertainty regarding interaction between multiple criteria. OWA helped to provide landfill suitability values in the range of zero and one. Again OWA helped them in the process of decision making for realizing patterns which are derived by decision alternatives as well as to define the risk in quantity.

In [17**]** A. Afzali and et al. successfully attempted to find out the most suitable area for landfill development in Isfahan city using multi criteria evaluation method with GIS technology. In this attempt information layers were weighted by applying Analytical Hierarchy Process. Fuzzy logic is applied to superposing the various information layers of topography. The researchers drag out the unsuitable area and suggested suitable site from remaining area for landfill. During the study researchers gone through steps such as 1) analysis method 2) constraint analysis 3) Evaluation of criteria 4) Final landfill map identification. To complete the study they considered physical criteria, environmental criteria, socioeconomic criteria, to derive the result of research work as suitable landfill site, using the expression as written below the constraints and factors are protected with each other.

$$\mathrm{SI} = \sum_{i=1}^{N} w_i x_i \times \prod_{j=1}^{K} b_j$$

Where in the above expression SI is total suitability index, W_i is weight of factor, X_i is score of criterion of factor i and N is the total factor criteria.

Ni-Bin Chang in [18] presented a fuzzy multicriteria decision analysis combining with geospatial analysis to decide landfill sites in the city Harlingen of south Texas. In the methodology two way stage analyses to create the SDSS Spatial decision support system is proposed. The work is carried ahead through two phases. In the first phase analysis of thematic maps of environmental, biophysical, ecological and socioeconomic factors is done using GIS. In the second phase work of analysis is done using fuzzy multicriteria decision making (FMCDA). In the present study FMCDM technique is adopted due to lack of crisp data, which need the evaluation of numerous available alternatives against various criteria needs assessment by fuzzy variables. In the study it is shown that using FMCDM it is possible to ranking the different landfill sites for the area. The list of criteria were applied for evaluating the merits of various landfill sites in the study is 1) environmental and ecological impact, 2) transportation issues, 3) impacts on historical markers, (4) economic impacts of the landfill and (5) public nuisance. The decision weights provided by decision makers are treated as a triangular fuzzy members and the overlapping of the fuzzy sets values are considered for defining similarity between the decisions of two experts to decide the upper limit of importance of a particular criterion in the decision making. It is really a different approach proposed by the researcher for decision making of landfill selection with the combination of advanced technology of GIS and soft computing methods.

[19] In this article Montserrat Zamorano and et al. has presented EVIAVE method which is discovered in the University of Grandad. This method is particularly devised for landfill sites assement for particularly of the region of Europen Union legislation. Using this method defines general indices to quantify most required environmental impact as well as indices regarding specific environmental criteria like surfacewater, groundwater, atmosphere, soil and human helth. While working for selection of suitable landfill sites researchers have spatial analysis tools for generationg geodatabase. Alos used composite evaluation criteria. They also used multiple

criteria analysis methods to generate the suitability index. Particularly Simple additive weighting (SAW) is used with combination of MCA. For completion of task required Probability of Contamination Indicators for each environmental component is determined using equation

$$\mathrm{Pbc}_i = \frac{\sum_{j=1}^{j=n} \mathrm{CRI}_j - \sum_{j=1}^{j=n} \mathrm{CRI}_{j_{\mathrm{minimum}}}}{\sum_{j=1}^{j=n} \mathrm{CRI}_{j_{\mathrm{maximum}}} - \sum_{j=1}^{j=n} \mathrm{CRI}_{j_{\mathrm{minimum}}}}$$

and the environmental risk index is calculated using formula

$$\mathrm{ERI}_i = \mathrm{Pbc}_i \times \mathrm{eV}_i$$

Landfill suitability index is calculated using formula

$$\mathrm{LSI} = \sum_{i=1}^{i=5} \mathrm{ERI}_i$$

[20] Alireza Khorram and et al. has done the critical study to acceptable in all point of views Landfill Site Selection by Using Fuzzy Logic and Geographic Information Systems for the Study area in Bardaskan, East of Iran. This study is done by considering the importance of solid waste management by the view of municipality. The first and most important priority problem in front of municipality is the proper management of solid waste. In that sense researchers has carried their research work by using GIS and Fuzzy theory. They have used GIS to prepare the required data, analyze the data store the data, represent the data. The theory of fuzzy logic is utilized to process the decision making. The first phase of research is carried out by using GIS and the second phase is carried out using Fuzzy theory. In the second phase the distance from each criterion to the nearest source is calculated with Euclidean distance approach. After that the generated maps revised by their degree of importance, Then again reclassified to given cell quantities and changed by new output cell quantities as per their fuzzy membership functions. The landfill selection processes the passes through the steps like 1) Determination of Membership Functions, and 2) Combination of Fuzzy Membership Values. The final result of the work is the appropriate landfill site is suggested.

[21] is again the research study made by V. Akbari and et al. for the solving problem related to management of solid waste of Bandar Abbas, Iran. For the solution to the management of solid waste authors has proposed to use the sustainable landfill site. The task of finding sustainable land fill for Bandara Abbas authors followed the methodology of combining GIS and fuzzy multi criteria decision analysis against various different criteria. The methodology specifies tow sections or work to develop the spatial decision support system (SDSS). The first part GIS digital map overlay methods are applied. For the study authors considered many parameters like distance to urban and rural area, distance to industrial and agricultural areas, distance to permanent and seasonal rivers, distance to fault, terrain slope, underground water level, transportation network, soil type, geology, and both present and future land use of the area. In the next part analysis uses fuzzy multi criteria decision making (FMCDM) for ranking various landfill sites. The required Triangular fuzzy number is calculated using expression

$$\mu_{\tilde{A}}(x) = \begin{cases} 0, & x \le a \\ \dfrac{x-a}{b-a} & a \le x \le b \\ \dfrac{c-x}{c-b} & b \le x \le c \\ 0, & c \le x \end{cases}.$$

[22] is a development of model for selecting a valid landfill site by Sohaib K. M and et al. While developing this model writers have used the integration of Python-ArcGIS and Matlab for spatial and nonspatial data handling and coding. The help of neural networks technology is adopted to complete the task. The development process is spitted into total 9 stages and for case study the north Peninsular Malaysia area is used. Total 22 criteria were considered in this study for selection of landfill. The nine steps A to I are used in this work and can be summarized as

A) Sampling: In this stage the maps of criteria and landfill map where processed and a set of attributes data set is generated for neural network.

B) Raster layer Processing: The classification of non-landfill as zero and landfill as one of polygons of case study map is made.

C) Extraction of dataset: In addition to stage A all the raster layers in the form of spatial criteria is to be added. The sequence of layers is maintained as fields in the attribute set. Also to indicate the input criteria in the dataset, the derived binary map is added on the first layer. From the raster layers the attributes were generated as grid points as well as the target map in the form of zero

and one is also generated. This stage provides the grid sample points and its attributes with all data about input criteria and target label for each point.

D) Pre-processing of Data: Here to arcpy.da.SearchCursor is used to derive dataset. This stages gives TXT files as an output having processed data values. Due to this stage uses can able use the data for various statistical softwares, decide the related criteria, and skip the irrespective criteria in the study. For training and testing purpose Matlab can be used on this data.

E) Neural Network Training: Under the environment of Matlab the training and testing is carried out and network is trained to overcome the errors. The user has to provide the quantity of neurons for hidden layer.

F) Tiles Grid generation: In this stage the area of prediction is separated into tiles. It produces the TXT files also the the TXT file of metadata file is created which will be useful for final determination of land suitability.

G) Training Subset: This Stage builds the required training subsets to each tile on the basis of given raster layers.

H) Prediction: In this stage the testing of output datasets is carried out and the values of Y as output are find out and stored as array of vectors in the form of TXT.

I) Mapping of Suitability: It is the ending step in which the final suitability map is derived. In this the required suitabiloyt maps were generated using the Y arrays of TXT files. It uses the addition of Y TXT files , Coordinate system and the metadata file. Also it takes the output workspace, names of output maps and mask layer in this tool. This is iteratively done against Y. Finally gives the suitability map.

[23] is a mathematical approach to solve the uncertainty problems in landfill site selection introduced by Rasha Elhadary and et al. This study concentrates on use of the technique of rough set classification and minimization of attributes for landfill selection. This experiment is performed on the cities Mansoura, Dekerness of Egypt. The theory of Rough set was first introduced in 1982 by Zadzislaw Pawlak of Polish researcher. It is a data mining technique of classification. Using this technique it is possible to analysis the attributes, removal of non important attributes and to optimize the decision table as well as decision rules. Throughout the empirical study researchers follows the following sequences of steps. 1.Indiscernibility Relations

2.Boundary Approximation 3. RS1 Algorithm 4.Evaluation Metrics FroRough set Rules 5. Rough Set Issues: Indiscernibility sets from continuous data 6.Quantization of Continuous data Seta 7.Domain Driven Method. This study showed that Rough Set theory can be implemented for knowledge generation and reduction of human efforts up to some extent and also indicates which data needs to be updated as per the decision rules. As this is capable to reduce attributes and their values while discovering knowledge, the rough set technique can be applied to omit the unwanted attributes with their information and which helps the decision makers to increase the efficiency and reduce the error rate.

[24] is a research article for land suitability evaluation by C. Parthiban and et al. The first and important objective of this study is to find the land suitability for specific crop. At the same time this study helps to decide the best classification algorithm among Naïve Bayes and J48 on the basis of accuracy, performance, error rate and execution time. This study helps to the farmers of Andaman by giving suggestions about particular land is unsuitable, highly suitable or moderately suitable for the crop. The needed data for the study is gathered for CIAR which is Agricultural research center at Port Blair. It gives total eight soil types of islands and this contains eleven attributes along with 112 soil types. The training data set is also used. The rules are created for classification and to suggest the recommendations by developing the logic. The research work shows that algorithm J49 is best as compare to NaiveBayes algorithm on the basis of good accuracy, performance measure and minimum error rate. It is also found that the NaiveBayes takes minimum time than J48 for data classification.

Sohaib K. M. Abujayyab and et al. in [25] explained the intellectual work for mapping the suitability of landfill sites with the help of neural networks and GIS. They said that this is a multidiscipline study area. They exerted this study for the area of north states in Malaysia. During this study they utilized total 14 criteria to prepare the dataset. The outcome of this study is nothing but a toolbox. The designed toolbox helps to the decision makers to perform neural network approach for mapping the suitability of landfill sites with ArcGIS. As Python supports the ArcGIS authors used the Python scripting to develop the toolbox. The designed toolbox works on the basis of three layered perceptron neural network as input layer, hidden layer and output layer. The toolbox completes total six sequential stages for supporting decision makers.

These stages are categorized as 1. Preparation of sample points, 2. Pre-processing of dataset, 3. Neuron Network training, 4. Final prediction with dataset processing, 5. Prediction and 6. Suitabiliy mapping. The main advantage of splitting tool box in stages helps to avoid the congestion in cache memory. It also helps to decision makers to reduce time and avoid confusing in data processing. This study shows that four states are having best sites. Again it explains the 57.84 percent area comes under very low suitability , 26.56 pecent comes under low suitability , 2.89 percent comes under moderate suitable and 1.86 comes under high suitable for landfill.

F. Karimipour and et al. in [26] presented the role of data mining approach in exploring relationship, future scope of spatial data. This study is devoted to study the geospatial data mining, its importance and analysis. Along with this purpose the study also covers the role of geospatial data mining in data management related to environment and water quality management. At last the study about the support of industries and the impact of industries on water quality regarding population in industrial area is discussed about the Azerbaijan Provinces in North-West of Iran. This article shows that we cannot avoid the use of new technology of extracting information form database i.e. the support of GIS and geospatial data mining regarding extraction of information is helping the decision makers to select the industrial site by accessing the criteria related to the water quality. Also this study suggested that the use of temporal spatial data will enhance the purpose of decision makers.

Muhammad Shaheen in [27] discussed the details about site suitability for wind turbine position. The selection of particular location is finding out by considering the following 10 criteria

1. Speed of wind
2. Forests,
3. Builtups
4. Elevation
5. Land type,
6. Ownership, land interferences,
7. Geological structure of earth surface,
8. Nearest energy installation
9. Cost of installation and

10. Ecological impacts on living things.

The needed data for site suitability is obtained by applying principal component analysis and multiple regression analysis techniques on total 35 numerous sites of Pakistan. These techniques were used for two purposes 1.To reduce the dimensionality of dataset 2.For Prediction of suitability of new wind turbine installation by considering historical facts. From spatial and nonspatil data the GIS data is prepared. Using principal component analysis dimensions reduction of data is made. The generated principal components are used as input for regression analysis technique and the prediction of suitable site for wind turbine is made. In this study the potential value is set for each site after the process of multiple regression and then the sites were sequenced on the basis of these values. The multiple regression equation provides the value of potential for a site to for wind turbine.

P. K. S.C. Jayasinghe and et al. has done the study in [28] about discovering most suitable areas for forest production by using the advanced techniques like Spatial Data Mining, GIS and remote sensing. For the purpose of data mining Artifical Neural Network was used. As the criteria land use, average annual rainfall, soiel erosion, slope, and fire hazards were considered while study. The required data for study is qcquired form the satellite image ASTER-VNIR (Level 1B) of dated July 2006. This image was distributed into0 total 8 classes of land use. The slope map is generated using Digital Elevation Model. The vegetation area is found out using normalized Difference Vegetation Index. The needed rainfall and soil maps were generated form digitization method from thematic maps. For Artificial Neuron Network modeling Alyuda NeuroIntelligence 2.2 was applied for standard Back-Propagation algorithm. ANN helped to find the optimal neural network structure. Spreadsheet is used to store the final result and then used in GIS for the final result in the form of final map. Using the final produced map the suitable areas were classified into the forest production. They got such three suitability classes. The study result gives most suitable, suitable and less suitable classes of land as 19.65, 28.43 and 51.93 percent respectively. The total study passes through four stages to complete the goal. These stages are as 1. Producing current land use map using Supervised Classification. 2. Deriving vegetation cover map using NDVI, 3. Producing soil erosion vulnerable map using Overlay analysis and 4. Finding most suitable area for forest production by applying ANN. Except these stapes study also needs following procedures

1. Digitizing soil and rainfall map.
2. Finding important factors
3. Determining slope maps
4. Satellite image processing
5. Classification of land use
6. Determination of vegetation map
7. Determination of soil erosion map
8. Producing fire hazards maps

In this study authors used data of Madagama in Uva province, Monaragala district of SriLanka as study area.

[29] is a study about finding optimal location and capacity planning of distributed biomass power generation facilities using combination of spatial data mining and GIS by Deepak Paramashivan Kaundinya and et al. This study considered the spatial data of Tumkur district in India for caring the experiment. In this study the k-medoid clustering algorithm is used for dividing the region into clusters as villages. During experimental study of this research papers the value of k is find out recursively by applying the algorithm for total area for various values of k along with demand and supply constraints matching. The values which minimizes the cost of installation, transportation and transmission and distribution is selected for k is decided.

[30] is the study completed by Prof. Dr. Alaa H. AL-Hamami and Dr. Soukaena H. Hashem with the aim of optimization of the cells towers distribution with the help of spatial mining and GIS. The study is trying to minimize the number of towers by feasible location for full coverage area. To achieve the goal researchers had used Digital Elevation Model and also apply the rules of spatial association at the second level for selecting the optimum location to antenna. The total study completed through six steps. The first step is Deciding External Grid: In this step DEM is applied to divide the image to Grid and external grid. As per the coverage area each square in the grid will relate with a cell. The second step is deciding External Grid: Here every cell represent the region is to be covered by tower hence each grid will also fragmented as internal grid. The third step is preprocessing the internal grid: In this step data mining steps are applied to process

the objects and grids. Fourth step is mining the internal grid. The fifth step is classifying the squares of the internal and the final sixth step is selecting the optimum square.

[31] is the article written by Nadjim Chelghoum and et al. for presenting the capability of decision tree of classifying spatial data. In this article writers have introduced a new technique SCART. SCART is somewhat different than decision tree. This method is advancement in Classification and Regression Tree (CART) technique. Using these study writers has attempted to identify relevant risk models for supporting traffic safety. Particularly this study finds out the analysis of sections of roads that are risky with concern to accidents and presents the relativity of accidents with respect to geographic of road area. The resultant classification algorithm is built up using spatial join index and relational data mining technique. Twoing indice formula is used as it is mostly suitable in case of multiple classes attributes for splitting. The splitting of node is ended if every object present in the node is again in the same garget attribute class and such node is defined as pure. Splitting will even stop as there are no criteria available for enhancement of resulting information. Again minimal occupation of the node becomes the next criteria that are the largest depth of tree or it can be called as threshold value for information gain. From the spatial data mining point of view, representation of the spatial association in tabular form is a challenging task , and the proposed method by writers can applied to spatial clustering , spatial association .

In [32] Nadjim Chelghoum and et al. suggested the decision tree algorithm for spatial data processing by considering ID3 logic as base. Using this approach they showed that the geographical features like point, line as well as polygon can be represented. They empirically showed that two spatial objects can be joined to establish the spatial decision tree using small spatial data. As per writers the proposed algorithm provides 74.72 percent accuracy for points and polygons against the result producing decision trees. In these study only points, lines and polygons are considered. Classification algorithms were used for mining of set of layers. The set of layers is classified tin two sections as explanatory layers and target layer on the basis of spatial association. The target layer includes attributes along with garget attribute and that target attribute contains target classes. In case of explanatory layer each layer contains multiple attributes and among them one is predictive attribute which is used for classification of tupples from the dataset for target classes. For this study both attributes are categorical. To create a

tuples having every value from tuple corresponds to value of these layers the features in the garget layer associated with features in explanatory layers. Here two dissimilar layers are associated to generate the new layer by applying spatial association. Association among two layers causes the production of spatial measure for the new layer. Now this spatial measure can be used in the formula to gaining spatial information.

[33] is successful attempt showing that the Decision Tree algorithm is applicable for land suitability analysis and is done by Hou yajuan and et al. Before making conclusion, researchers has studied the decision tree and learning algorithm. For performing practical thre land sites were considered to utilize by C4.5 and implemented with objected oriented language C++. The gained results are compared with results from literature with using random sampling. The researchers predicted that the complete analysis of land nature and the socioeconomic condition of different land is nothing but the land suitability or it is the classification of land area into grades according to certain conditions, and the used conditions cab used as attributes and the grade can be considered as class for decision tree. During experiment total eight attributes are considered and these are from the features terrain slope, irrigation condition, soil texture, thickness of arable layer, organic matter, total nitrogen, available phosphorous, readily available potassium of soil, In the same manner the total four classes were considered as highly suitable, suitable, receivable suitable and non suitable. Finally they conclude that decision tree algorithm is suitable in the land suitability problems.

[34] is a research article to develop the model for predicting hotspot occurrence in locations for fire in forests by researchers Imas Sukaesih and his colleague Mohd Hasmadi Ismail. This study is completed using the data of Rokan Hilir district in Indonesia. C4.5 decision algorithm was used to introduce the application of decision tree. To predict the hotspot occurrences the set of IF-THEN rules is applied. The used spatial data includes the location of hotspot occurrences, such as human activities which causes fire, city centers, roads, rivers and land covers. In this study the attributes having hotspot occurrences and non occurrences were known as positive examples and negative examples relatively. Total eighteen classification rules are applied in the algorithm. Also decision tree algorithm gives analysis about the area is mostly under fire occurrences. The generated decision tree is having total 18 leaves and 26 nodes providing accuracy as 63.17 percent. The leaf node represents the positivity and negativity of hotspot

occurrences. Attribute testing is done on the basis of root node and internal nodes. The validation of proposed model is done by applying the model for new areas of forest fires. The proposed model helps to decide the fighting strategies against wildfire stopping. From the study it is also clear that the data mining technique is like decision tree for forest fire data to develop the classification model about predicting hotspot occurrences.

In [35] Zhe Jiang and et al. presented a new decision tree learning algorithm that covers the impact of spatial autocorrelation with the spatial information gain (SIG) approach. For empirical purpose authors has used the remote sensing data of Chanhassen, MN which is a city of Carver, Hennepin counties of state Minnesota. Through this study authors showed that the used approach helps to improve the classification accuracy as compare to traditional methods regarding reduction of salt-n-pepper noise. As per authors study the study of geographical classification methods is important for landuse, landcover classification, lesion classification in medical field. The spatial classification helps the climate scientists to analyze the global warming concept. The present study explores the spatial autocorrelation aware decision tree learning algorithm and it is the solution to reduce salt-n-peeper noise in traditional decision tree learning algorithm and enhance the accuracy in classification process. To complete the objective of study authors gone through the steps like 1) Basic concept, 2) Proposed Interestingness Measure, 3) Spatial Decision Tree Learning Algorithm, 4) Evaluation, 5) Dataset and Settings, and finally 6) cross checking of results that is Does incorporating spatial autocorrelation improve classification accuracy? In the Basic concept step Entropy and Gain information is calculated. In the second step they decided to use local gamma autocorrelation formula. Again Neighborhood Split Autocorrelation Ratio (NSAR) is also finding out. Spatial Information Gain (SIG) is discovered . Actually SIG is the value for balancing reduction in class impurity and spatial autocorrelation. In the next step the algorithm of spatial decision tree learning is employed.

4. **OBJECTIVES**

The main aim of this study is to identify most suitable site/sites for solid waste using intelligent system GIS and soft computing, with the point of view to protect the environment and public health. With this aim the following objectives are framed for the present study.

- To assess the existing problems of solid waste with the perceptual study, to the case study area.
- To analyses the information on solid waste generation, collection and transportation.
- Mapping the Land use/Land cover categories using GIS technique to prepare required data for study model.
- Mapping of Municipal Corporation area with different ward boundaries and attributes data.
- To device a suitable decision support model to identify solid waste site.
- Creation of a GIS database for decision support system and identifying appropriate site/sites for the solid waste.

5. METHODOLOGY

While doing the present study it is decided to follow up the following methodology to easily achieve the aim and objectives of study.

1. Preparation of needed data.
2. Find the most suitable criteria.
3. Decide the weights/ importance/priority of the criteria.
4. Extracting required geographic data and features by using Arc GIS software.
5. Preparing spatial layers related to decided criteria.
6. Applying Buffering to the criteria layers and generating its new buffered boundary layers.
7. Overlying of layers.
8. Using traditional and soft computing techniques to identify the suitable solid waste site.
9. Test the defined model.

6. IMPORTANCE OF THE STUDY

Before seeking the importance of study we must consider the situation of solid waste management and its related problems. The importance of study at international, national and regional point of view is that, even though we are progress in our leaving standards and using most advanced technologies in our day-to-day life the consciousness and awareness about waste and its management is not at that level at which our living standards are there. Even it is truth that the generation of waste is increasing as there is increase in living standard and at the same

time no one is conscious about the management of waste. The problem of management of solid waste is critical and complicated at regional, national as well as international level.

If we thing about the regional level and village level, there is no any management system available for handling solid waste. It has many reasons such as citizens are not conscious about the solid waste. They didn't think seriously about it, and if they decide about management then the problems related to money cannot be fulfilled by the small villages. That is the economy of villages has nearly impossible to separate the budget for solid waste management. Due to such situations humans in villages may face the problems related to health.

The situation in cities is not so different than villages. But the situation at national level is very serious as the problem of managing solid waste is more complicated and difficult. The standard of living in big cities is very high, and it is the main cause of generating solid waste. The amount of generation of solid waste in cities is in tones per day. The value and cost of area in cities is very high, so to make available the dumping site for solid waste is not affordable to the municipalities. Again the industrial areas are in the city increases the solid waste.
India needs such a waste management system which is able to effectively handle the situation of waste management. It needs to adopt the most advanced solid waste management systems as in developed countries. There must be a well defined plan and its strong implementation to stop epidemic as well as to maintain the health and economy of environment. Also it needs to find out the strength, weaknesses of the community and municipalities and decide the best solution as per it. Also public awareness helps to control the bad impact of waste on environment [36].

At international level many of the countries are not economically capable to accept the advanced techniques to treat the soled waste. Only few and developed countries are using advanced techniques to treat the solid waste. At global level various countries are facing environmental and health related problems by adopting traditional methods for waste management.

This research proposes a very uncommon and suitable model to identify solid waste sites for Municipal Corporation using new technology GIS and soft computation. The major contribution of this research work can be summarized at international, national and regional level as

- It helps the decision makers to decide most suitable solid waste site.
- It handles the huge spatial data easily.
- It helps to analysis the spatial data easily.
- It saves the time of decision makers.
- It is very easy to study existing problems of solid waste disposal by using this study.
- It is capable to promptly analysethe information on solid waste generation, collection and transportation.
- Its ability to mapping the different Land use/Land covers categories.
- Its ability to mapping of considered area with different ward boundaries and attributes data.
- It is capable to create database for decision support system, and selecting a suitable site for solid waste.

This scientific analytical work will obviously helps the NandedWghala city Municipal Corporation to keep clean ad healthy city.

Scope of the study:

The extended study can help to identify the landfill sites for solid waste. Again the work can be extended to work for recycling of waste; energy creation etc. The advancement in this study will again helpful to make planes related to aesthetics of town.

7. PROPOSED WORK PLAN

To complete the study in time it is decided to go through the following work plan phases.

Phase 1.

Submission of synopsis to the institute Swami Ramanand Teerth Marathwada University.

Phase 2.

Preparation of required data to carry the study and deciding criteria.

Phase 3.

Decide the weights/ importance/priority of the criteria.

Phase 4.

Extracting required geographic data and features by using Arc GIS software.

Preparing spatial layers related to decided criteria.

Phase 5.

Applying buffering to the criteria layers and generating its new buffered layers, and overlying of layers.

Phase 6.

Identification of suitable solid waste site/ sites Using soft computing techniques, and test the defined model.

Tentative Chapter Scheme

Chapter1. Abstract and Introduction

Chapter 2. Literature Review

Chapter 3. Methodology

Chapter 4. ArcGIS and various techniques

Chapter 5. Emperical work

Chapter 6. Result and Conclusion

8. YEAR WISE PLAN OF WORK AND TARGETS TO BE ACHIEVED

The table given below explains the year wise plan of work.

Phases	Expected work	Expected duration in months
Phase 1.	Research proposal, Abstract, Introduction,	3
Phase 2.	Literature review,	3
Phase 3.	Deciding Technique and Preparation of data,	6
Phase 4.	Applying the method and obtain the outcome	6
Phase 5.	Thesis Binding	3
Phase 6.	Other related work	3

9. EXPECTED OUTCOME

It is expected that the study will end by identifying suitable sites for solid waste using proposed model.

10. REFERENCES

[1] "Solid Waste Management: Issues and Challenges in Asia", Report of the APO Survey on Solid-Waste Management 2004–05, Edited by the Environmental Management Centre, Mumbai, India

[2] "SOLID WASTE MANAGEMENT IN THE WORLD'S CITIES WATER AND SANITATION IN THE WORLD'S CITIES 2010", United Nations Human Settlements Programme, UNOHABITAT, Earthscan, Publishing for a sustainable Future, London. Washington, DC.

[3] CHAPTER 5 –MUNICIPAL SOLID WASTE MANAGEMENT: TURNING WASTE INTO RESOURCES, Shanghai Manual – A Guide for Sustainable Urban Development in the 21st Century.

[4] Debishree Khan[1] and S.R. Samadder[2].2014.Application of GIS in Landfill Siting for Municipal Solid waste.International Journal of Environmental Research and Development.

[5] Suman Paul. 2012. Location allocation for urban waste disposal site using multi-criteria analysis: A study on Nabadwip Municipality, West Bengal, India. International Journal of Geomatics and Geosciences.

[6] TirusewAyisheshim Ebistu[1] and AmareSewnet Minale[2]. November 2013. Solid waste dumping site suitability analysis using geographic information system (GIS) and remote sensing

[7] Solid Waste Management-“GPS and GIS enabled” Caese :Pimpri-Chinchwad Municipal Corporation.forBahir Dar Town, North Western Ethiopia. African Journal of Environmental Science and Technology.

[8] Md. Mujibor Rahman[1], KaziRuksana Sultana[2] and Md. Ahasanul Hoque[3].February 2008. Suitable Site for Urban Solid Waste Dispolal Using GIS approach in Khulna City, Bangladesh.Proc. Pakistan Acad. Sci.

[9] Tamilenthi. S[1], Chandra Mohan. K[2], Vijaya Lakshmi. P[3] and R. S. Suja Rose[4].2011. The data base, land use and land cover and solid waste disposal site – using remote sensing and GIS: A case study of Sakkottai block, Sivagangai District, Tamil Nadu, India. Pelagia Research Library Advances in Applied Science Research

[10] AshtashilVrushketuBhambulkar. Municipal Solid waste Collection Routes Optimized with ARC GIS Network Analysis.International journal of advanced Engineering Sciences and Technology.

[11] Surendra Kumar Yadav. 2013. GIS Based Approach for Site selection in Waste Management. International Journal of Enviromnetal Engineering and Management.

[12] Prof. S. Sheina, Prof. L. Babenko, Prof.R. Matveyko, S. Nedelko 29 June 2012 Methodology of municipal solid waste management system using the GIS-technologies.14thInternationla Conference on Computing in Civil and Building Engineering.

[13] Ayo Babalola, Ibrahim Basu December 10th 2010. Selection of Landfill Sites for solid waste Treatment in Damaturu Town –Using GIS Technology, Journal of Environmental Protection, 2011.

[14] BilgehanNas.Tayfun Cay. FatihIsdan. Ali Berktay. 24 Jan 2009. Seletion of MSW Landfill site for Konya, Turkey using GIS and multi-criteria evaluation. Springer Science +Business Media B.V.2009

[15] A. Karkazi, T. Hatzichristos, A. Mavropoulos, B. Emmanouilidou, Ahmed. Elseoud. . *LANDFILL* SITING USING GIS AND FUZZY. LOGIC ,Egyptian Environmental Affairs Agency.

[16] Pece V. Gorsevski, Katerina R. Donevska, Cvetko D. Mitrovski, Joseph P. Frizado, Integrating multi-criteria evaluation techniques with geographic information systems for landfill site selection: A case study using ordered weighted average, Waste Management 32 (2012) 287–296.

[17**]** A. Afzali, J. M. V. Samani, M. Rashid. MUNICIPAL LANDFILL SITE SELECTION FOR ISFAHAN CITY BY USE OF FUZZY LOGIC AND ANALYTIC HIERARCHY PROCESS**,** Iran. J. Environ. Health. Sci. Eng., 2011, Vol. 8, No. 3, pp. 273-284, Received 12 June 2010; revised 12 April 2011; accepted 14 August 2011.

[18] Ni-Bin Chang, G. Parvathinathan, Jeff B. Breeden. Combining GIS with fuzzy multicriteria decision-making for landfill siting in a fast-growing urban region, Journal of Environmental Management 87 (2008)139–153, www.elsevier.com/locate/jenvman.

[19] Montserrat Zamorano, Emilio Molero, A lvaro Hurtado, Alejandro Grindlay. Evaluation of a municipal landfill site in Southern Spain with GIS-aided methodology, Journal of Hazardous Materials 160 (2008) 473–481, journal homepage: www.elsevier.com/locate/jhazmat

[20] Alireza Khorram, Maryam Yousefi, Seyed Ali Alavi, Javad Farsi. Convenient Landfill Site Selection by Using Fuzzy Logic and Geographic Information Systems: A Case Study in Bardaskan, East of Iran, Health Scope. 2015 February; 4(1): e19383, Published online 2015 February 20.

[21] V. Akbari, M.A. Rajabi, S.H. Chavoshi and R. Shams, Landfill Site Selection by Combining GIS and Fuzzy Multi Criteria Decision Analysis, Case Study: Bandar Abbas, Iran, World Applied Sciences Journal 3 (Supple 1): 39-47, 2008 ISSN 1818-4952 © IDOSI Publications, 2008.

[22] Sohaib K. M. Abujayyab[1, a)], Mohd Sanusi S. Ahamad[1, 2, b)], Ahmad Shukri Yahya[1, c)], Siti Zubaidah Ahmad[1, d)] and Hamidi Abdul Aziz1, [2, e)], Automating an Integrated Spatial Data-Mining Model for Landfill Site Selection, Proceedings of the International Conference of Global Network for Innovative Technology and AWAM International Conference in Civil Engineering (IGNITE-AICCE'17) AIP Conf. Proc. 1892, 130001-1–130001-8; https://doi.org/10.1063/1.5005757 Published by AIP Publishing. 978-0-7354-1574-4/$30.00

[23] Rasha Elhadary, Aluned Elashry, NEW APPROACH FOR LANDFILL SITE SELECTION USING SPATIAL ROUGH SET, Computer Engineering Conference (ICENCO), 2011 Seventh International, 27-28 Dec. 2011, Giza, Egypt, **NSPEC Accession Number:** 12556857, **DOI:** 10.1109/ICENCO.2011.6153932 , **Publisher:** IEEE, IEEE Catalog Number: CFP1132N-CDR ISBN: 978-1-4673-0729-1

[24] C.Parthiban[1], M.Balakrishnan[2] , Expert System for Land Suitability Evaluation using Data mining's Classification Techniques: a Comparative Study, *March 2016, International Journal of Computer Trends and Technology (IJCTT) – Volume 33 Number 2*

[25] Sohaib K. M. Abujayyab [a,] Mohd Sanusi S. Ahamad* [a], Ahmad Shukri Yahya [a], Hamidi Abdul Aziz [a&b], SPATIAL DATA MINING TOOLBOX FOR MAPPING SUITABILITY OF LANDFILL SITES USING NEURAL NETWORKS, The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLII-4/W1, 2016 International Conference on Geomatic and Geospatial Technology (GGT) 2016, 3–5 October 2016, Kuala Lumpur, Malaysia

[26] F. Karimipour[1], M. R. Delavar1[*] and M. Kinaie[2], Water Quality Management Using GIS Data Mining, 05JEI00047, 1726-2135/1684-8799 © 2005 ISEIS www.iseis.org/jei, Journal of Environmental Informatics 5 (2) 61-72 (2005) doi:10.3808/jei.200500047

[27] Muhammad Shaheen, Muhammad Shahbaz, Khalid Afsar Khan Jadoon, Data Mining For Wind Energy Site Selection, Proceedings of the World Congress on Engineering and Computer Science 2012 Vol I WCECS 2012, October 24-26, 2012, San Francisco, USA

[28] P. K. S.C. Jayasinghe[*1] and Masao Yoshida [2], Integrating Spatial Data Mining Technique to Identify Potential Areas for Forest Production Using GIS and Remote Sensing, Agricultural Information Research 19(2), 2010. 23-35, www.jstage.jst.go.jp/

[29] Deepak Paramashivan Kaundinya[a,b,c,*], P. Balachandra[b,c], N.H. Ravindranath[c], Veilumuthu Ashok [c], A GIS (geographical information system)-based spatial data mining approach for optimal location and capacity planning of distributed biomass power generation facilities: A case study of Tumkur district, India,Contents lists available at SciVerse ScienceDirect Energy journal homepage: www.elsevier.com/locate/energy

[30] Prof. Dr. Alaa H. AL-Hamami, Dr. Soukaena H. Hashem, Optimal Cell Towers Distribution by using Spatial Mining and Geographic Information System, *World of Computer Science and Information Technology Journal (WCSIT) ISSN: 2221-0741 Vol. 1, No. 2, 44-48, 2011*

[31] Nadjim Chelghoum , Karine Zeitouni, and Azedine Boulmakourl. A Decision Tree for Multi-Layered Spatial Data, Symposiun on Geospatial Theory, Processing And pplications, July 9-12, 2002, Ottawa, Canada, Volume XXXIV Part 4, 2002,ISPRS Commission IV, Symposium 2002

[32] Imas Sukaesih Sitanggang, Razali Yaakob, Norwati Mustapha, Ahmad Ainuddin B , Nuruddin. An Extended ID3 Decision Tree Algorithm for Spatial Data, 978-1-4244-8351-8/11/$26.00 ©2011 IEEE

[33] Hou yajuan, Liu yaolin, Ren zhouqiao. Application of Decision Tree on Land Suitability Analysis, International Conference on Earth Observation Data Processing and Analysis (ICEODPA),Vol.7285,72854I·©2008SPIE·CCCcode:0277786X/08/$18·doi:10.1117/12.814848, Proc. of SPIE Vol. 7285 72854I-1

[34]Imas Sukaesih Sitanggang, Mohd Hasmadi Ismail. Classification model for hotspot occurrences using a decision tree method, Geomatics, Natural Hazards and Risk, Vol. 2, No. 2, June 2011, 111–121

[35] Zhe Jiang, Shashi Shekhar, Pradeep Mohan, Joseph Knight, Jennifer Corcoran. Learning Spatial Decision Tree For Geographical Classification: A Summary of Results, 20th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems (ACM SIGSPATIAL GIS 2012) November 6-9 2012 — Redondo Beach, California

[36] Dr . Raveesh Agarwal, Mona Chaudhary, Jayveer Singh. Waste Managemetn Initiatives in India for Human Well Bing, European Scientific joural June 2015/SPECIAL/edition ISSN:1857 – 7881(Print) e – ISSN 1857 – 7431.

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